ITUPublications
Recommendations

International Telecommunication Union
Standardization Sector

Recommendation

ITU-T Y.3161 (12/2023)

SERIES Y: Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities

Future networks

Intent-based network management and orchestration for network slicing in IMT-2020 networks and beyond

ITU-T Y-SERIES RECOMMENDATIONS

Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities

GLOBAL INFORMATION INFRASTRUCTURE	Y.100-Y.999
General	Y.100-Y.199
Services, applications and middleware	Y.200-Y.299
Network aspects	Y.300-Y.399
Interfaces and protocols	Y.400-Y.499
Numbering, addressing and naming	Y.500-Y.599
Operation, administration and maintenance	Y.600-Y.699
Security	Y.700-Y.799
Performances	Y.800-Y.899
INTERNET PROTOCOL ASPECTS	Y.1000-Y.1999
General	Y.1000-Y.1099
Services and applications	Y.1100-Y.1199
Architecture, access, network capabilities and resource management	Y.1200-Y.1299
Transport	Y.1300-Y.1399
Interworking	Y.1400-Y.1499
Quality of service and network performance	Y.1500-Y.1599
Signalling	Y.1600-Y.1699
Operation, administration and maintenance	Y.1700-Y.1799
Charging	Y.1800-Y.1899
IPTV over NGN	Y.1900-Y.1999
NEXT GENERATION NETWORKS	Y.2000-Y.2999
Frameworks and functional architecture models	Y.2000-Y.2099
Quality of Service and performance	Y.2100-Y.2199
Service aspects: Service capabilities and service architecture	Y.2200-Y.2249
Service aspects: Interoperability of services and networks in NGN	Y.2250-Y.2299
Enhancements to NGN	Y.2300-Y.2399
Network management	Y.2400-Y.2499
Computing power networks	Y.2500-Y.2599
Packet-based Networks	Y.2600-Y.2699
Security	Y.2700-Y.2799
Generalized mobility	Y.2800-Y.2899
Carrier grade open environment	Y.2900-Y.2999
FUTURE NETWORKS	**Y.3000-Y.3499**
CLOUD COMPUTING	Y.3500-Y.3599
BIG DATA	Y.3600-Y.3799
QUANTUM KEY DISTRIBUTION NETWORKS	Y.3800-Y.3999
INTERNET OF THINGS AND SMART CITIES AND COMMUNITIES	Y.4000-Y.4999
General	Y.4000-Y.4049
Definitions and terminologies	Y.4050-Y.4099
Requirements and use cases	Y.4100-Y.4249
Infrastructure, connectivity and networks	Y.4250-Y.4399
Frameworks, architectures and protocols	Y.4400-Y.4549
Services, applications, computation and data processing	Y.4550-Y.4699
Management, control and performance	Y.4700-Y.4799
Identification and security	Y.4800-Y.4899
Evaluation and assessment	Y.4900-Y.4999

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T Y.3161

Intent-based network management and orchestration for network slicing in IMT-2020 networks and beyond

Summary

Recommendation ITU-T Y.3161 specifies intent-based network management and orchestration for network slicing in IMT-2020 networks and beyond. This architecture guides the network slice deployment and management based on an intent-based network.

History *

Edition	Recommendation	Approval	Study Group	Unique ID
1.0	ITU-T Y.3161	2023-12-14	13	11.1002/1000/15741

Keywords

Intent-based, IMT-2020, management and orchestration.

* To access the Recommendation, type the URL https://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents/software copyrights, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the appropriate ITU-T databases available via the ITU-T website at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T Y.3161

Intent-based network management and orchestration for network slicing in IMT-2020 networks and beyond

1 Scope

This Recommendation describes intent-based network management and orchestration for network slicing in IMT-2020 networks and beyond. This Recommendation covers, but is not limited to, the following items:

- Requirements of intent-based network management and orchestration for network slicing in IMT-2020 networks and beyond;
- The architecture of intent-based network management and orchestration for network slicing in IMT-2020 networks and beyond;
- Representative mechanism of intent-based network management and orchestration for network slicing in IMT-2020 networks and beyond;
- Procedures of intent-based network management and orchestration for network slicing in IMT-2020 networks and beyond.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Y.3159] Recommendation ITU-T Y.3159 (2023), *Framework for classifying network slice level in future networks including IMT-2020.*

[ITU-T Y.3160] Recommendation ITU-T Y.3160 (2023), *Architectural framework of end-to-end service level objective guarantee for future networks including IMT-2020.*

[ITU-T Y.3325] Recommendation ITU-T Y.3325 (2023), *Framework for high-level AI-based management communicating with external management systems.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 artificial intelligence (AI) [b-ITU-T E.749.13]: An interdisciplinary field, usually regarded as a branch of computer science, dealing with models and systems for the performance of functions generally associated with human intelligence, such as reasoning and learning.

3.1.2 intent [b-3GPP TS 28.312]: A formal specification of all expectations including requirements, goals and constraints given to a telecom system, without specifying how to achieve them.

3.1.3 network slice [b-ITU-T Y.3100]: A logical network that provides specific network capabilities and network characteristics.

NOTE 1 – Network slices enable the creation of customized networks to provide flexible solutions for different market scenarios which have diverse requirements, with respect to functionalities, performance and resource allocation.

NOTE 2 – A network slice may have the ability to expose its capabilities.

NOTE 3 – The behaviour of a network slice is realized via network slice instance(s).

3.1.4 network slice instance [b-ITU-T Y.3100]: An instance of network slice, which is created based on network slice blueprint.

NOTE 1 – A network slice instance is composed of a set of managed run-time network functions, and physical/logical/virtual resources to run these network functions, forming a complete instantiated logical network to meet certain network characteristics required by the service instance(s).

NOTE 2 – A network slice instance may also be shared across multiple service instances provided by the network operator. A network slice instance may be composed of none, one or more subnetwork slice instances which may be shared with another network slice instance.

3.1.5 IMT-2020 [b-ITU-T Y.3100]: Systems, system components, and related technologies that provide far more enhanced capabilities than those described in [b-ITU-R M.1645].

3.1.6 network function [b-ITU-T Y.3100]: In the context of IMT-2020, a processing function in a network.

NOTE 1 – Network functions include but are not limited to network node functionalities, e.g., session management, mobility management and transport functions, whose functional behaviour and interfaces are defined.

NOTE 2 – Network functions can be implemented on a dedicated hardware or as virtualized software functions.

NOTE 3 – Network functions are not regarded as resources, but rather any network functions can be instantiated using the resources.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

IBN Intent-Based Networking

IBNMO Intent-Based Network Management and Orchestration

KPI Key Performance Indicator

NSI Network Slice Instance

QoE Quality of Experience

SLA Service Level Agreement

5 Conventions

In this Recommendation:

The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted, if conformance to this Recommendation is to be claimed.

The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

6 Overview

An intent-based network (IBN) is an emerging technology concept that aims to apply a deeper level of intelligence and intended state insights to networking. It allows administrators to specify slice customers' requirements by using business-level intent, a high-level abstraction of "what to do", rather than specifying the low-level details of "how to do". IBN can translate users' intents into suitable network configurations to deploy resources on underlying network infrastructure. Meanwhile, it can also continuously verify the consistency between the network execution strategy effect and the original intent through real-time monitoring of network status and optimize the allocation of network resources when users' intents are not satisfied.

Therefore, introducing the technical concept of IBN into the management and orchestration for network slicing can be a promising solution to improve the efficiency and flexibility of network slice management. Figure 6-1 shows an overview of intent-based network management and orchestration (IBNMO) for network slicing. By using AI and other technologies, IBNMO translates users' slice requirements into network configuration parameters and automatically executes resource orchestration. IBNMO can perceive user experience and network slice's performance based on real-time network status and dynamically optimize network slice configuration to ensure that users' intents can be satisfied during the whole lifecycle of network slices, while reducing operation and maintenance expenses.

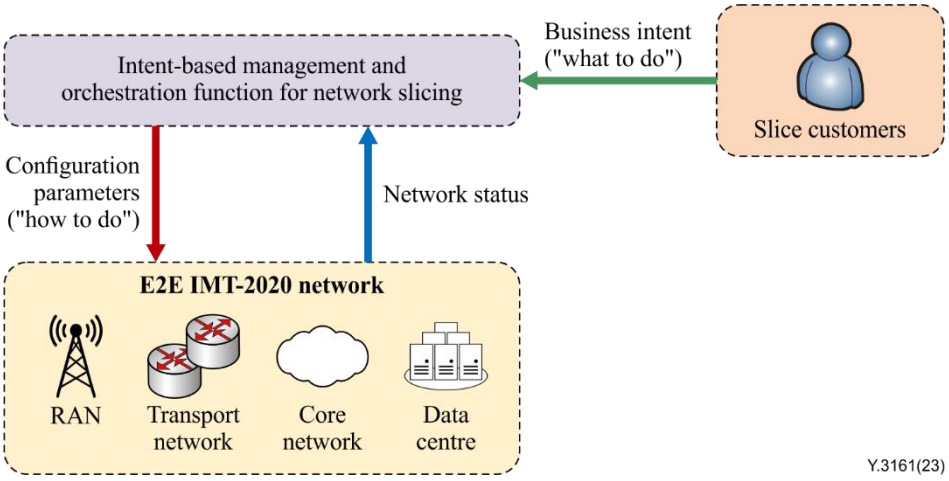

Figure 6-1 – An overview of intent-based network management and orchestration for network slicing

7 Requirements of intent-based network management and orchestration for network slicing in IMT-2020 networks and beyond

7.1 Requirements for intent translation

[REQ-IT-1]: IBNMO is required to support slice customers to input high-level business intents which may be the form of non-specific information.

[REQ-IT-2]: IBNMO is required to analyse the customers' business intents to identify and eliminate semantic ambiguities and conflicts.

[REQ-IT-3]: IBNMO is required to build a mapping between customers' intents and network slice attributes based on present and historical data.

NOTE – Data contains network status and the feedback from the network after translation and corresponding configurations.

[REQ-IT-4]: IBNMO is required to translate high-level business intents into concrete network configuration parameters through AI technologies.

7.2 Requirements for configuration verification

[REQ-CV-1]: IBNMO is required to verify the feasibility of the current network configuration parameters to cover the slice customers' requests, mainly considering the availability of resources, the conflict of policies and the correctness of policies.

[REQ-CV-2]: IBNMO is required to optimize the network configuration parameters if slice customers' intents cannot be realized.

[REQ-CV-3]: IBNMO is required to analyse if the newly created or updated network slices will affect the operation of the existing network slices.

[REQ-CV-4]: IBNMO is required to evaluate the priority, urgency and estimated deployment time of network slices before deployment.

7.3 Requirements for autoconfiguration

[REQ-AC-1]: IBNMO is required to establish and maintain a network slice template repository which consists of various types of slice templates for various business intents.

[REQ-AC-2]: IBNMO is required to search the matching network slice templates according to the configuration parameters.

[REQ-AC-3]: IBNMO is required to update the configuration parameters of the existing network slice templates or create a new network slice template according to the business intents.

[REQ-AC-4]: IBNMO is required to dynamically adjust the network slicing configuration according to the current traffic load of network slices.

[REQ-AC-5]: IBNMO is required to release the network configuration resources when the lifecycle of some customers' intents ends; the corresponding released resources can be used and optimized for other intents.

7.4 Requirement for intent verification

[REQ-IV-1]: IBNMO is required to monitor the real-time operation status of a network slice instance (NSI) and collect network slice information such as network slice QoE and key performance indicator (KPI).

[REQ-IV-2]: IBNMO is required to analyse collected network information and verify the consistency between NSI's operation status and the original intent.

[REQ-IV-3]: IBNMO is required to adjust network slice configuration parameters when the slice customer's intent is not satisfied after the intent verification.

[REQ-IV-4]: IBNMO is required to predict whether customers' intents can be satisfied in a pre-configured period (e.g., 5 minutes later) under the current network configuration based on real-time data, and generate new configuration parameters if the customers' intents are not satisfied in a pre-configured period.

[REQ-IV-5]: IBNMO is required to adjust the network configuration parameters according to the present utilization situation of network resources without affecting existing network slices based on customers' intents.

8 Architecture of intent-based network management and orchestration for network slicing in IMT-2020 networks and beyond

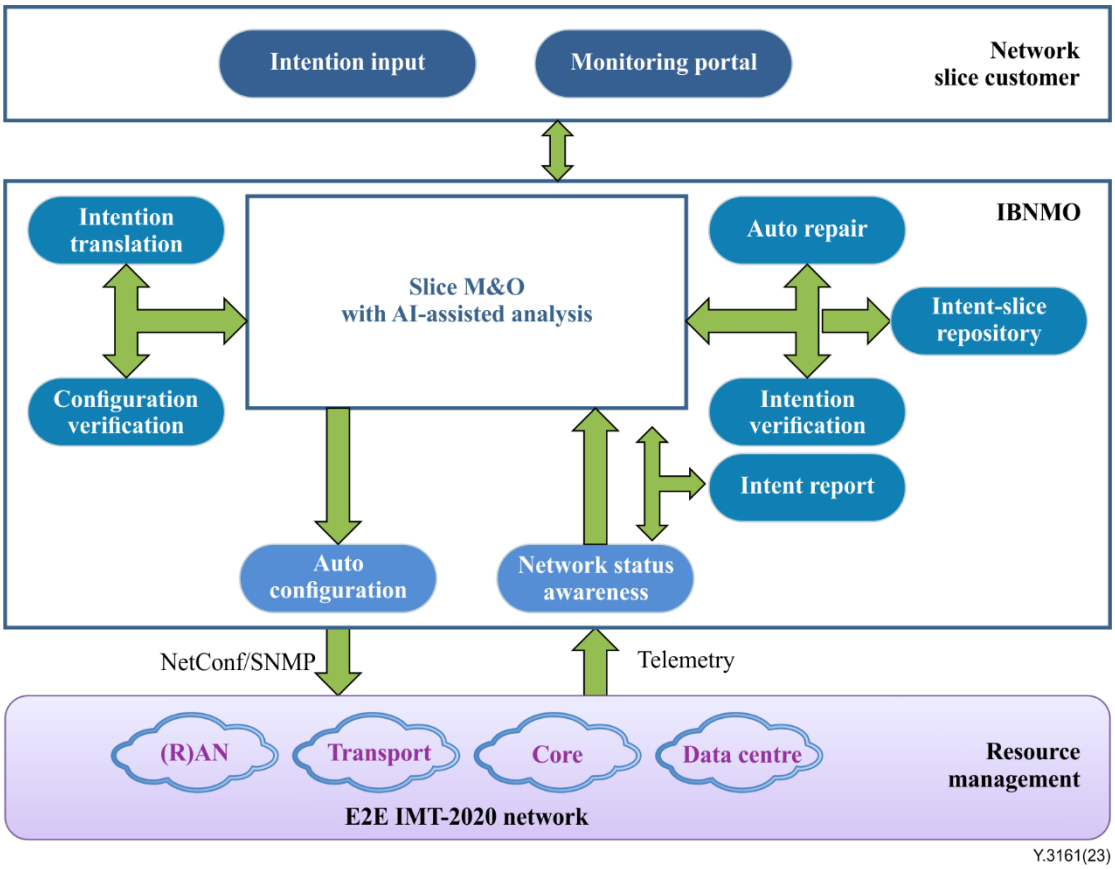

Figure 8-1 – The architectural framework of intent-based network management and orchestration for network slicing

Intention input: This is provided as a form of a portal service for end users. It is the first step in the realization of user intent. Intent is a managed object, and has its management operations, e.g., user's request to create an intent, update an intent, query an intent, delete an intent and subscription to intent report.

Intention translation: This abstracts the specific network performance requirements, such as bandwidth, latency and jitter from intention input and convert intent into network configuration parameters by AI technologies or according to the pre-configured templates.

Configuration verification: It is to verify the configuration by using the digital twin network or in the actual operating network environment. Through the simulation or the feedback from actual configuration, some abnormal problems based on the configuration can be found such as address conflicts, routing loops and unreachable routes.

Automated configuration: It is to automatically set the network configuration to IMT-2020 network infrastructure for execution after the configuration verification has been completed.

Network status awareness: It obtains the information of network status from IMT-2020 network infrastructure through information collection technologies (e.g., telemetry technology). The status includes device status, link status, service types and traffic status. The timeliness and comprehensiveness of the collected data is the key to the accuracy and completeness of the configuration verification.

Intention verification: This verifies in real time whether the final result of the user's intent in the IMT-2020 network infrastructure is satisfied, and predicts whether the user's intent can be satisfied in the future through AI/machine learning algorithms. It also detects the potential faults and their causes in advance based on network slice status, and executes configuration optimization.

Automated repair: This is conducted based on the results of intention verification to diagnose and analyse intent conflicts or existing network faults and to quickly delimit and locate the fault points. This function automatically repairs or assists network managers to repair the fault.

Intent report: This obtains the requirements of intent users, generates intent reports and responds with the intent reports to the intent users, allowing them to be notified of the intent handling state and intention verification result.

Intent-slice repository: This is to store the knowledge between intent and slice management, by extracting the knowledge from the intent handling processes, such as intention translation, intention verification and automated repair.

Monitoring portal: This is to monitor the operation status of users' intent.

IMT-2020 network infrastructure: This is resources for realizing users' intent including network resources, storage resources, computing resources and security resources.

9 Representative mechanism of intent-based network management and orchestration for network slicing

9.1 General description

The IBNMO for network slicing shall allow the network slice consumer to invoke the network resources through the use of intents. The representative mechanism shall support the capabilities for the multi-intention management of network slice, intent-based verification, IBN measurement and feasibility check of the intents.

9.2 Method for multi-intention of network slice creation/modification

When the intention input receives the intentions for network slice creation/modification from multiple network slice customers, the multiple intentions need to be prioritized first to avoid the resource conflicts caused by network slice creation/modification.

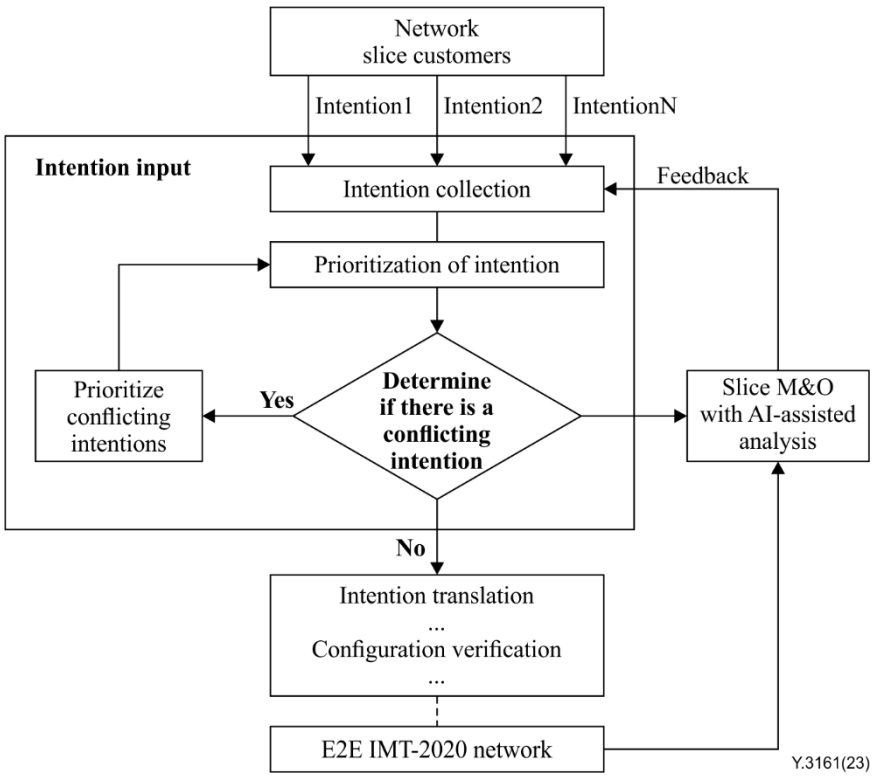

Figure 9-1 – High-level method of multi-intention of network slice creation/modification

In the intention input, the intentions for network slice creation/modification are first prioritized after the intention collection has received the intentions from network slice customers. The prioritization of the intentions is based on the four steps from 1) to 4) to be judged in turn:

1) First, determine whether they are the intentions of multiple network slice customers, if yes, perform this judgement, if no, turn to the second judgement. To prioritize the intentions of slicing customers according to the SLA requirements, which means the network slice customers signed with network slice providers. The intentions of network slice customers with high SLA requirements have high priority to create/modify the network slices. Obtain the prioritization result, and perform the next priority judgement.

2) The second judgement is based on step 1, determining whether they are the intentions of multiple network slices from a network slice customer; if yes, perform this judgement, if no, turn to the third judgement. For one network slice customer to create/modify multiple network slices, this needs to be created/modified according to the network slice level defined in [ITU-T Y.3159]. The intentions of network slices with a high network slice level have high priority to create/modify. Obtain the prioritization result, and perform the next priority judgement. If there is only one network slice, proceed to the next stage of judgement.

3) The third judgement is based on step 2, determining whether they are the intentions of multiple attributes of a single network slice; if yes, perform this judgement, if no, turn to the last judgement. To prioritize the intentions of attributes of a network slice, according to service requirements (for example, priority guarantee for services with lower latency requirements, and high isolation requirements) obtain the prioritization result, and perform the next priority judgement.

4) The last judgement is based on the result of step 3 to determine whether it is the intention of the attribute of the closed-loop feedback; if yes, perform this judgement, if no, close the judgement. While collecting intents for network slicing customers, if a certain attribute in the feedback information which may include the feedback value of the attribute has been created and judged, this attribute will be preferentially configured according to the feedback information.

After the four judgements, the intentions of network slice creation/modification are passed to the intention translation function, converting the intentions into the configuration of the network slices, and then performing the configuration verification. After successful verification in IBNMO, the configuration can be performed.

9.3 Method for intent-based verification

When the intention input receives the intentions for network slice creation/modification from the network slice customers, these intentions will be translated to the specific network configuration parameters (e.g., KPIs), and break down from the slice management and orchestration (M&O) to the subdomain M&O, including the access network domain M&O, transport network domain M&O and core network domain M&O [ITU-T Y.3160]. To guarantee the service experience of network slice customers, the slice M&O needs to verify the configuration information before execution. The following method is taking the latency as an example to perform the verification when the network slice customers intend to create/modify the network slice.

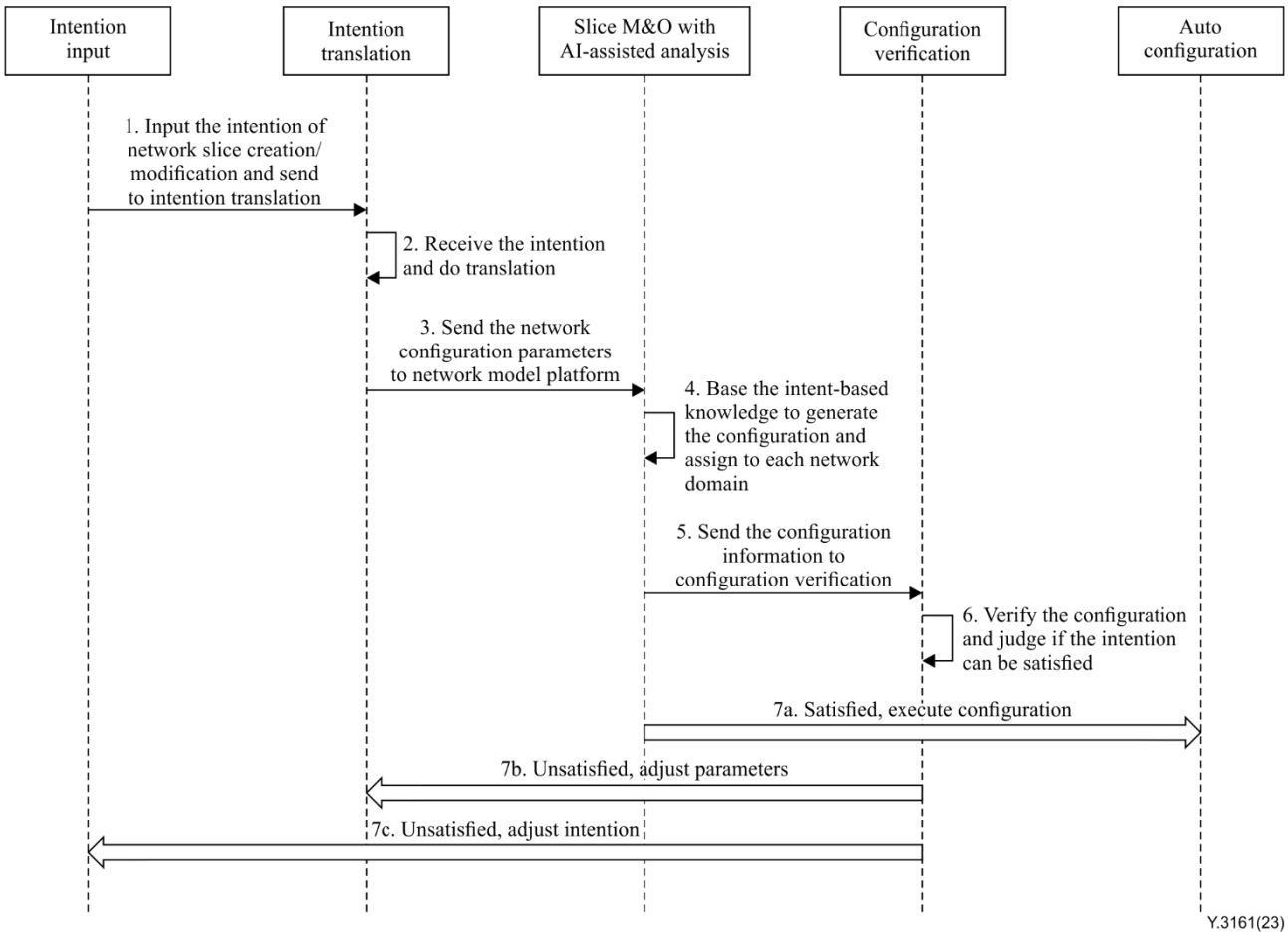

Figure 9-2 – An example of intent-based verification

(1) The intention input receives the intentions to create/modify the network slice from the network slice customers.

(2) The intent translation function converts the intent input performance indicators into network configuration parameters; the main configuration information can be divided into network slice requirement information and network slice requirement QoE information [ITU-T Y.3160]:

– Network slice requirement information can be network function (NF) performance measurement data, fault supervision data, network QoS data, etc.

– Network slice QoE requirement information can be network coverage area, number of subscribers and customer satisfaction.

(3) Intention translation sends the network configuration parameters to the slice M&O with AI-assisted analysis and performs policy validation requests.

(4) The configuration of the metrics is executed in slice M&O with AI-assisted analysis (e.g., it can be executed by the digital twin network or the network model platform) slice M&O with AI-assisted analysis generates the configuration and assigns to each network domain M&O, including the access network domain M&O, transport network domain M&O and core network domain M&O.

(5/6) Pass configuration parameter information to the configuration verification function, through the simulation and/or actual configuration on the actual network operation, to find some abnormal problems in the configuration, such as delay unsatisfied, address conflicts, routing loops or route unreachable. For example, the delay indicator is compared and judged by each domain's real-time measurement value or model calculation value to calculate whether the total delay can meet the user's demand.

(7a) Based on the configuration verification results, the slice M&O with AI-assisted analysis adjusts the configuration policy (e.g., upload/download capacity, jitter, maximum latency, network availability and other parameters dedicated to specific service requirements). The requirements are met and the configuration is sent down automatically to the network infrastructure through a standard configuration interface to create network slices for users.

(7b) After the real-time verification that the final result of the users' intent execution in the network infrastructure is not met, revert to the intent translation to adjust the parameters (indicating that the end-to-end network environment can meet the network slice creation requirements and readjust the method of assigning each domain metric for verification and distribution).

(7c) After the real-time verification, the final result of the users' intent executed in the network infrastructure is met, but the requirements are not met; adjust the users' intent (indicating that the IMT-2020 network environment cannot meet the network slice creation requirements, then readjust the intent).

9.4 Method for intent-based network measurement

When the intention input receives the intentions for network slice creation/modification, the network measurement needs to be performed automatically to be aware of the network status and ensure the accuracy of the configuration verification. Therefore, a flexible network measurement strategy is needed to meet the measurement requirements while reducing the resource usage.

Firstly, a high quality threshold and a low quality threshold are introduced to determine whether the current network and services can be normal. For example, a service requires a network latency of 10 milliseconds, and the average latency is 5 milliseconds when the network is running properly, which can meet the service requirement. In this case, the high quality threshold is set to 5 milliseconds, and the low quality threshold is set to 10 milliseconds.

There are three scenarios:

1) When the network indicator is better than the high quality threshold, the network is normal and services are running normally. Given the above example, when the network latency is less than 5 ms, both the service and the network are normal.

2) When the network indicator is between the high quality threshold and the low quality threshold, the network is abnormal, but the service can still run normally with a certain tolerance. When the network latency fluctuates, for example, reaching 8 ms, which exceeds the average latency of normal network operation but is less than the 10 ms required by the service, the network is abnormal but the service is normal.

3) When the network indicator is worse than the low quality threshold, the network is abnormal and services cannot run normally. For instance, when the network latency is larger than 10ms, the service is abnormal.

After the real-time network indicator is obtained, it can be compared with these two thresholds and different network measurement strategies are adopted. The strategies are as follows:

1) When the real-time network indicator is worse than the low quality threshold, the finest-grained measurement scheme is adopted, for example, the telemetry rate is the highest, and the device logs, status and alarm information of the whole network are extracted.

2) When the real-time network indicator is better than the low threshold but worse than the high threshold, a measurement scheme of medium granularity is adopted; for example, the telemetry rate is in medium, and a certain proportion of device logs and status information are extracted.

3) When the real-time network indicator is better than the high quality threshold, a coarse-grained measurement scheme is used, for example, the telemetry rate is low, and the status information of key node equipment is extracted.

Different measurement granularity corresponds to different measurement rates, such as the telemetry rate, active measurement packet sending frequency and passive measurement sampling ratio. The measurement rates for different granularities can be linearly increasing or fixed.

9.5 Method for feasibility check

When a network slice customer sends a request to the intention input to create an intent of network slice creation/modification, the intention input needs to provide intent management service (e.g., the creation of an intent instance). In order to reduce the costs and risks of intent execution, the intention input needs to perform feasibility checks of the intent first and then determine whether to create an intent instance according to the results of the checks. It is recommended that the customer be notified of these preliminary check results so that the customer can obtain an appropriate response to the request.

1) Firstly, a network slice customer sends a request to create an intent of network slice creation/modification to the intention input. In addition to the intent, this request needs to include some additional attributes to indicate that the intent can be preliminarily checked and the results obtained.

2) Then, when the intention input receives the request, it will determine the value of these additional attributes. One attribute is related to feasibility or maliciousness. The intention input will determine whether the received intent is malicious or not and feasible or not by assessing the intent preliminarily. For example, if the intention to create a network slice will have a negative impact on the operator network, then the intent can be considered malicious by IBNMO. Otherwise, the intent is not considered malicious. If the intention to create a network slice is within the service capability of the network, then the intent can be considered feasible, otherwise, the intent is not considered feasible.

3) After the preliminary judgement, if the intent is judged to be non-malicious and feasible, the intention input will determine the value of the attribute to be non-malicious and feasible and then consider creating an intent instance. If the intent is judged to be malicious or infeasible, this intent will not be executed. The intention input will also send a response to the network slice customer containing the checking results.

4) Considering multiple intents, another attribute is related to the relationship between intents. The intent input will determine whether the intent is related to the existing intents in the intent-slice repository by querying the repository. The following relationships are included:
   - Equal: if the requested intent is equal to an intent in the intent-slice repository, then the new intent can directly use the execution policy of the equivalent intent, e.g., the same network slice template.
   - Inheritance: if the goal or requirement of the requested intent is smaller than an existing intent in the intent-slice repository, then the new intent inherits from the existing intent. A part of the policy of the existing intents can be adopted.
   - Conflict: if the requested intent is in conflict with an intent, the policy of existing intents can be adjusted; refer to the method in clause 9.2.
   - Correlation: if the requirements or goals of the requested intent are similar to an intent in the intent-slice repository, then the new intent and the existing intent are related. The policy of relevant intents can be adjusted and then adopted.
   - Non-related: if the requested intent is not related to the intents in the intent-slice repository, the intent input passes this new intent to the intent translator to generate a new policy.
5) Based on the query results, the intention input can determine the value of the relational attribute and help quickly generate the intent execution policy. In addition, after the intent is executed and validated, the intent and its corresponding policy will be stored in the intent-slice repository.

10 Intent-based network slice lifecycle management

10.1 General description of intent-based network slice lifecycle management

10.1.1 Intent management operation

IBNMO can manage network slice service by the following intent management operations from the intent users' request:

- Create an intent: an intent user sends the request to IBNMO to create a new intent.
- Update an intent: an intent user sends the request to IBNMO to update an existing intent (e.g., intent expectations).
- Activate an intent: an intent user sends the request to IBNMO to activate an intent.
- De-activate an intent: an intent user sends the request to IBNMO to de-activate an intent.
- Query an intent: an intent user sends the request to IBNMO to be notified the of the intent handling state.
- Subscribe to intent report: an intent user sends the request to IBNMO to subscribe to the intent report.
- Delete an intent: an intent user sends the request to IBNMO to remove an intent.

10.1.2 Intent management state

Once receiving the intent request from the intent users, IBNMO needs to perform the corresponding management operations to handle the intents and give the feedback of intent management states to the intent users. Figure 10-1 illustrates the lifecycle management states of an intent as follows:

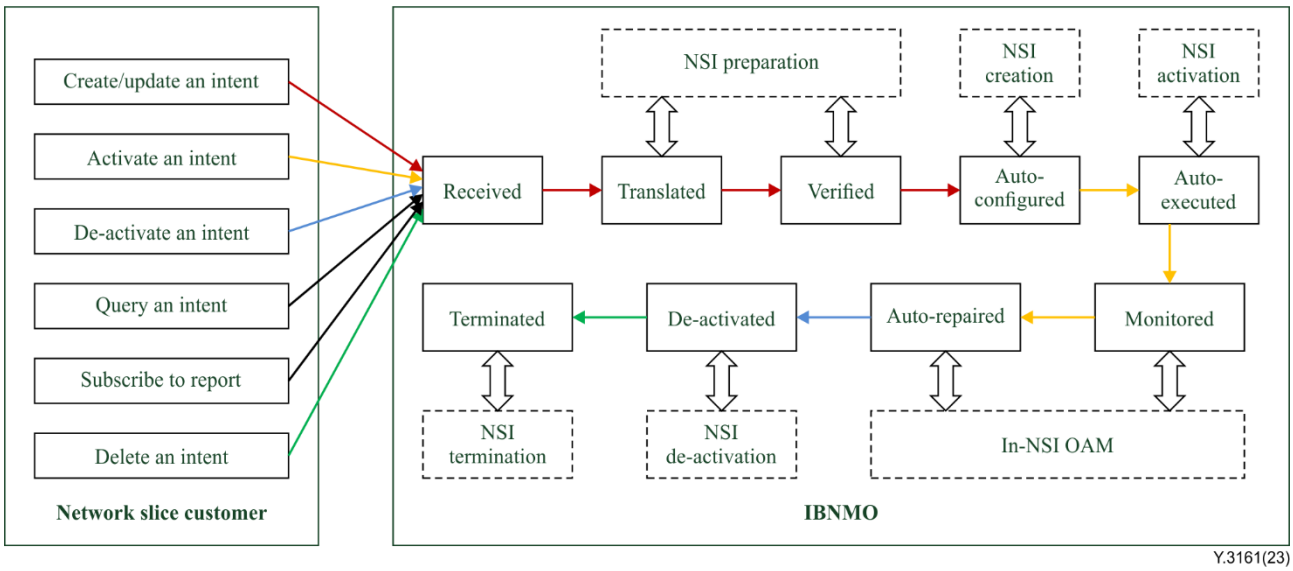

Figure 10-1 – Lifecycle management states of an intent

To achieve intent-based slicing life cycle management, the intent management state is described in Table 1.

Table 1 – Intent management state

Intent management state	Intent management state description
Received	This is the initial handling state of an intent and IBNMO will do the following operations according to the request of intent management operations.
Translated	This state is handled when the request is about the creation and update of an intent, and network slice template is selected or designed when an intent is in this state.
Verified	This state is handled when the creation/update request of an intent is translated successfully.
Autoconfigured	This intent is in this state after verifying the intent and then the corresponding NSI is created and configured.
Auto-executed	This intent is in this state when IBNMO receives the request to activate an intent and then the corresponding NSI is activated.
Monitored	This intent is in this state when an intent and its NSI is activated and in operation.
Autorepaired	This intent is in this state when IBNMO needs to deal with the intent conflicts, degraded network slice quality and network faults.
De-activated	This intent is in this state when IBNMO receives the request to de-activate an intent and then the corresponding NSI is de-activated.
Terminated	This intent is in this state when IBNMO receives the request to delete an intent and then the corresponding NSI is terminated.

IBNMO receives an intent management operation request sent by intention input from the network slice customer, and parses the intent management operation request, determines the target intent handling states based on which to process the intent and the NSI corresponding to the intent. The target intent handling states are the intent lifecycle management states, and each state in the intent lifecycle management states corresponds to the different lifecycle management states of the NSI.

IBNMO sends the response of the intent management operation request to the network slice customer, including the processing result of the intent and the NSI.

10.2 Procedures of intent-based network slice lifecycle management

10.2.1 Procedure for creating a new intent or updating an existing intent

Figure 10-2 illustrates the procedure for creating a new intent or updating an existing intent.

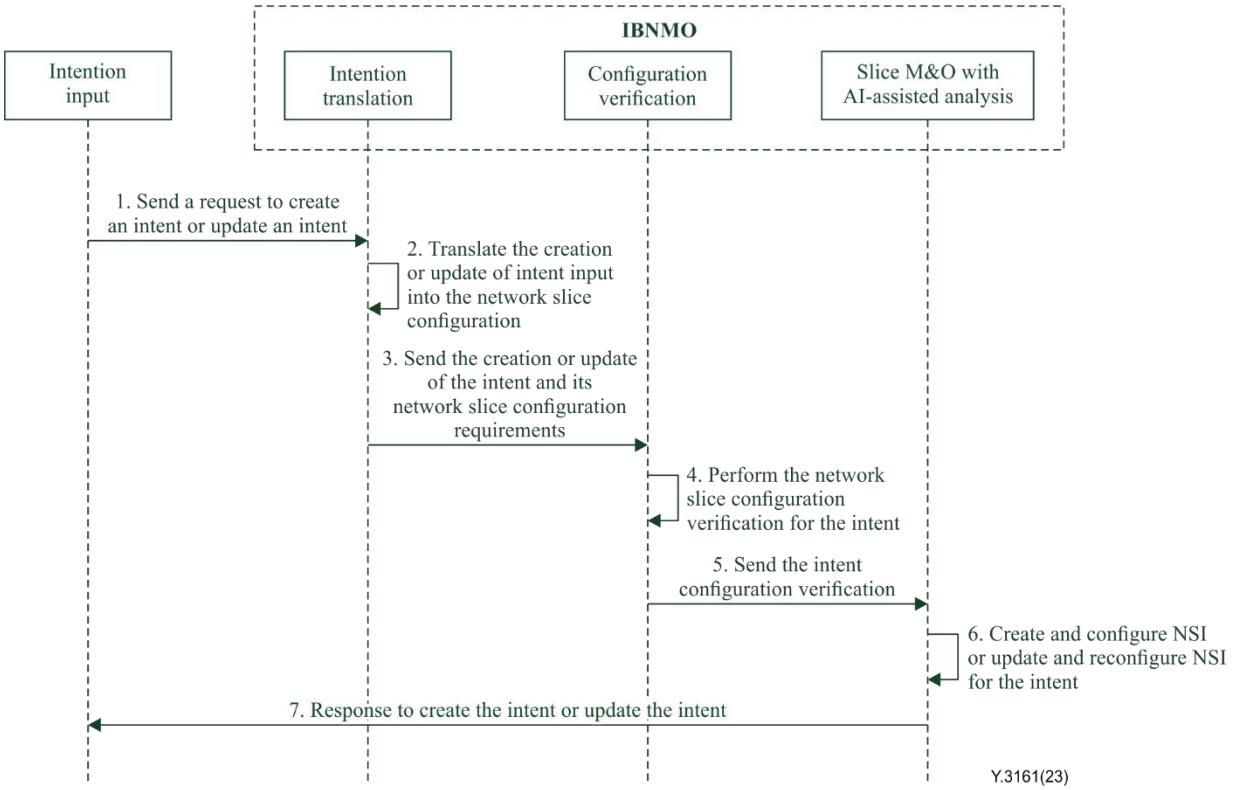

Figure 10-2 – Procedure for creating a new intent or updating an existing intent

(1) Intention input from slice customer sends a request to create an intent or update an existing intent to IBNMO.

(2) Once IBNMO receives the request, the intent translation function in IBNMO is supposed to translate the creation/update intent input into the creation/update network slice configuration based on the knowledge from the intent-slice repository, or predefined configuration rules or policies.

(3) The intention translation function sends the creation/update intent and its network slice configuration requirements after translation to the configuration verification function.

(4) The configuration verification function performs the creation/update network slice configuration verification for the intent.

(5) After that, the configuration verification function sends the intent verification result to the slice management and orchestration with AI-assisted analysis.

(6) Slice M&O with AI-assisted analysis creates or updates the NSI based on the intent request.

(7) IBNMO sends the response to the intent user to indicate whether the creation or update has been successful.

10.2.2 Procedure for activating an intent

Figure 10-3 illustrates the procedure for activating an intent.

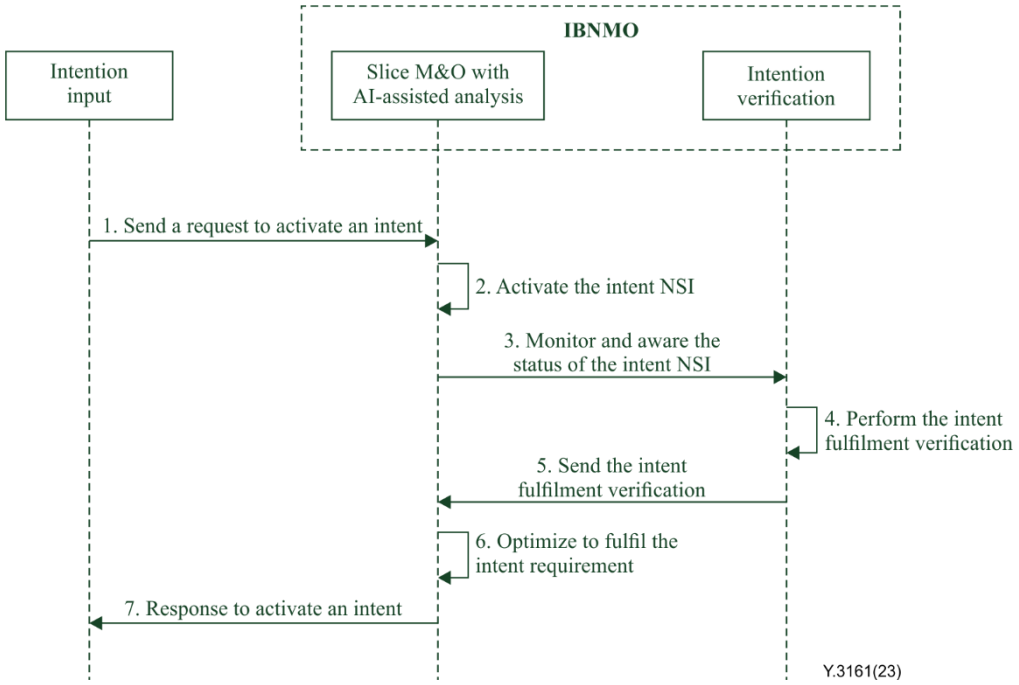

Figure 10-3 – Procedure for activating an intent

(1) Intention input from slice customer sends a request to activate an intent to IBNMO.

(2) Once IBNMO receives the request, the slice M&O with AI-assisted analysis is supposed to activate the NSI that has been created for the intent.

(3) Slice M&O with AI-assisted analysis sends the monitoring and awareness of the status of the intent NSI to the intent verification function.

(4) The intention verification function performs the intent fulfilment verification.

(5) After that, the intention verification function sends the intent verification result to the slice M&O with AI-assisted analysis.

(6) Slice M&O with AI-assisted analysis optimizes the NSI for the intent to fulfil the intent goals and requirements.

(7) IBNMO sends the response to the intent user to indicate whether the activation has been successful.

10.2.3 Procedure for querying an intent

Figure 10-4 illustrates the procedure for querying an intent.

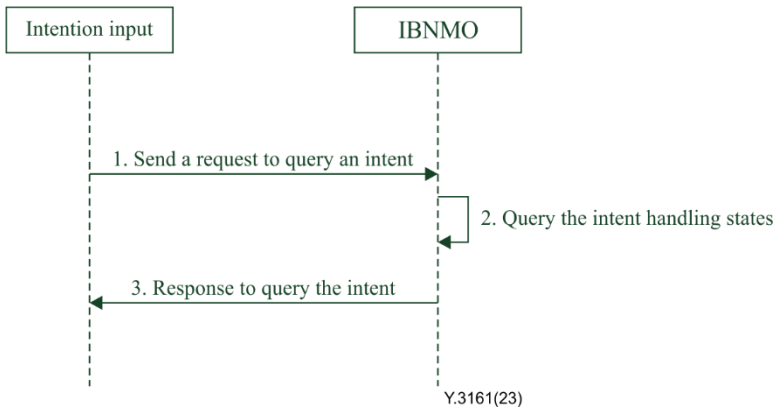

Figure 10-4 – Procedure for querying an intent

(1) Intention input from slice customer sends a request to query an intent.

(2) IBNMO receives the request and query the intent handling states and intent fulfilment.

(3) IBNMO sends the response to the intent user for notifying the query results.

10.2.4 Procedure for subscribing to an intent report

Figure 10-5 illustrates the procedure for subscribing to an intent report.

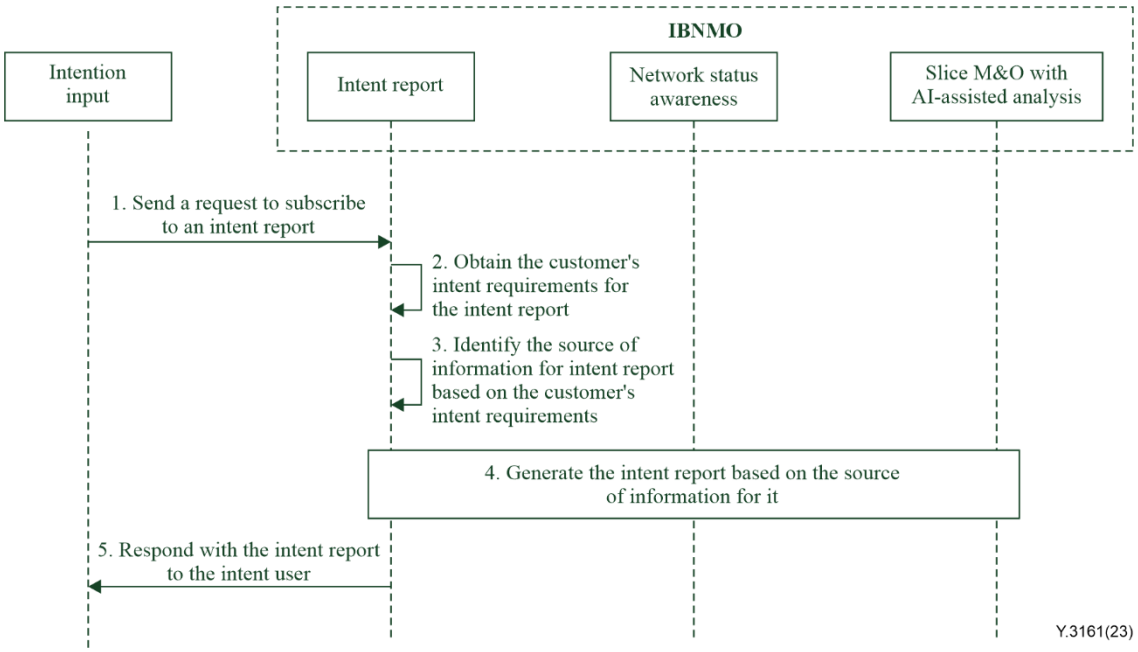

Figure 10-5 – Procedure for subscribing to an intent report

(1) Intention input from slice customer sends a request to subscribe to an intent report for an intent.

(2) The intent report function in IBNMO parses the intent report request and obtains the customer's intent requirements for the intent report, which include: SLA requirements and network measurement data requirements obtained based on the customer's intent expression, or SLA requirements obtained by translation of the intention input.

(3) The intent report function analyses and identifies the source of information for the intent report based on the customer's intent requirements. The source of information for intent report comes from network status awareness function and slice M&O with AI-assisted analysis, which include:

SLA metrics monitoring based on SLA requirements, and/or multimedia information determined by network status measurement data.

NOTE – Multimedia information is generated by using the analysis and prediction capabilities of the slice M&O with AI-assisted analysis and other related collected monitoring data for chart processing and display.

(4) The intent report function generates the intent report based on the source of information for it.

(5) The intent report function responds the intent report to the intent users.

10.2.5 Procedure for de-activating or deleting an intent

Figure 10-6 illustrates the procedure for de-activating or deleting an intent.

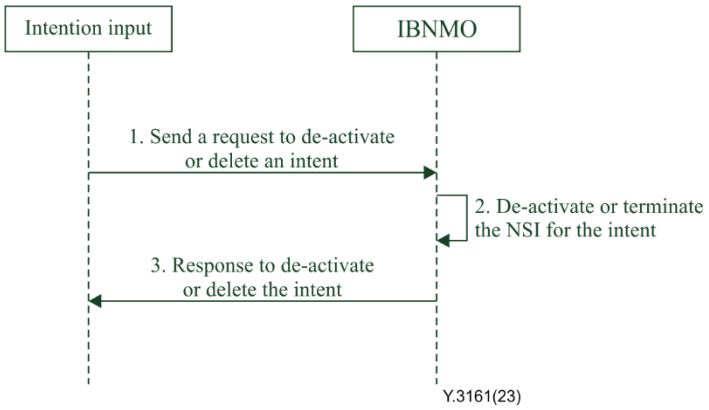

Figure 10-6 – Procedure for de-activating or deleing an intent

(1) Intention input from the slice customer sends a request to de-activate or delete an intent to IBNMO.

(2) IBNMO checks the NSI for the intent and de-activates or terminates the NSI for the intent. If it terminates the NSI it will then delete the intent configuration context.

(3) IBNMO sends a response to the intent user to indicate whether the de-activation or deletion has been successful.

11 Security considerations

The IMT-2020 network is subject to security and privacy measures. Sensitive information should be protected as a high priority in order to avoid leaking and unauthorized access. The security requirements are based on [b-ITU-T Y.3111] and [b-ITU-T Y.2701]. The reference model and interfaces for exchanging information between network slice customers and the capability exposure can be followed by [ITU-T Y.3325].

Bibliography

[b-ITU-T E.749.13] Recommendation ITU-T E.749.13 (2021), *Framework and requirements for civilian unmanned aerial vehicle flight control using artificial intelligence.*

[b-ITU-T Y.2701] Recommendation ITU-T Y.2701 (2007), *Security requirements for NGN release 1.*

[b-ITU-T Y.3100] Recommendation ITU-T Y.3100 (2018), *Terms and definitions for IMT-2020 network.*

[b-ITU-T Y.3111] Recommendation ITU-T Y.3111 (2017), *IMT-2020 network management and orchestration framework.*

[b-ITU-R M.1645] Recommendation ITU-R M.1645 (2003), *Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000.*

[b-3GPP TS 28.312] 3GPP TS 28.312 V18.0.0 (2023), *Intent driven management services for mobile networks (Release 18).*

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	Tariff and accounting principles and international telecommunication/ICT economic and policy issues
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling, and associated measurements and tests
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	**Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities**
Series Z	Languages and general software aspects for telecommunication systems

Published in Switzerland
Geneva, 2024